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Research Article

Rotator Cuff Tendon Rupture: Radio-Surgical Correlation

Sbaihi S[1], Ben Othmen N[1], Jlidi M[2], Bouaicha W[2]*, Daas S[2], Lamouchi M[2] and BouzaidiK[1]

[1]Radiology department. University Hospital Mohamed Taher Maâmouri Nabeul-Tunisia

[2]University Hospital Mohamed Taher MaâmouriNabeul-Tunisia

***Corresponding Author:** Bouaicha W, University Hospital Mohamed Taher MaâmouriNabeul-Tunisia.

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Abstract

Introduction: Rotator cuff tears are among the most frequent causes of pain and dysfunction of the shoulder. The role of imaging in such circumstances is therefore to identify the causative factors.

Our aims evaluate the performance of ultrasound versus magnetic resonance imaging in rotator cuff tears by correlating data from each technique to intraoperative data.

Methods: This was a retrospective study of 38 patients followed and operated for a rotator cuff tear. All patients were explored pre-operatively by ultrasound then by an MRI of the shoulder in the medical imaging department of the same hospital.

Results: The average age of the patients was 56 years with a discreet male predominance. The supraspinatus tendon was the most affected tendon. Ultrasound was as efficient as MRI in the detection of long head of the biceps dislocations with sensitivity and specificity of 100% and this was probably due to the reduced number of dislocations found 3 times per operative.

Conclusion: our study confirmed the literature data concerning the performance of MRI in the detection of rotator cuff tears, its better sensitivity and specificity compared to ultrasound for the detection of small tears.

Keywords: Rotator Cuff; Tendon Rupture; MRI; Ultrasound

Introduction

Rotator cuff tears, whose etiologies are numerous and varied, are among the most frequent causes of pain and dysfunction of the shoulder, resulting in a professional and social handicap that can be major for manual workers, hence the interest in early and adequate management, which will depend on the type and extent of the tear [1].

The role of imaging in such circumstances is therefore to identify the causative factors as well as to specify the tendon lesions and their extension, as cuff tendon ruptures are sometimes difficult to identify clinically [2].

Magnetic resonance imaging (MRI), considered to be the reference examination in transfixing or non-transfixing ruptures, as well as in the peri-articular atmosphere, remains a relatively expensive, unavailable and static examination [3].

Ultrasound, long neglected, is increasingly used as a first-line examination in the exploration of the rotator cuff thanks to improvements in the technological performance of the machines and to its many advantages, in particular its dynamic nature. However, the dependence of the operator on a long learning curve is frequently considered as its limit, in particular in the case of partial ruptures for which a strong inter-observer variability is noted [2].

The objective of our work was to evaluate the diagnostic performance of ultrasound versus MRI in rotator cuff tears by correlating the data from each imaging technique with intra operative data.

Methods

We conducted a retrospective and comparative study at the Medical Imaging Department in collaboration with the Orthopedic Surgery Department, over a period of 39 months from March 2014 to June 2017 and collected 38 records. It included patients in whom a rotator cuff tendon tear was suspected clinically and who were explored by ultrasound and MRI of the shoulder. All patients were operated on at the orthopedic surgery department.

All examinations were performed by the same operator using a GE Healthcare Logiq E9 machine with a high frequency probe (5 to 12 Mhz) and following the same technique.

All MRI examinations were performed with a GE Healthcare1.5 Tesla machine after ruling out any contraindications. The protocol was standard and included axial, oblique coronal, and oblique sagittal sequences in proton density weighting after saturation of the fat signal, T2-weighted oblique coronal sequences and T1-weighted oblique sagittal sequences.

The reading was performed by a resident physician and a senior physician on Advantage 4.6 plates or console.

The relevance of each radiological examination in the diagnosis of the various types of rotator cuff lesions was evaluated by first analyzing their intrinsic validity parameters: Sensitivity (Se), Specificity (Sp), Positive Likelihood Ratio (PLR) and Negative Likelihood Ratio (NLR) and then by comparing them according to the Youden test.

Results

The average age of the patients was 56 years with a discreet male predominance. The supra spinatus tendon was the most affected tendon with 34 lesions found intra operatively. These lesions were divided into 20 transfixing ruptures and 10 non-transfixing ruptures evoked respectively 20 and 10 times on ultrasound (Figure 1-3) and 21 and 13 times on MRI (Figure 4,5). Se and Sp were significantly better with MRI than with ultrasound, calculated at 91% versus 78% and 100% versus 87%.

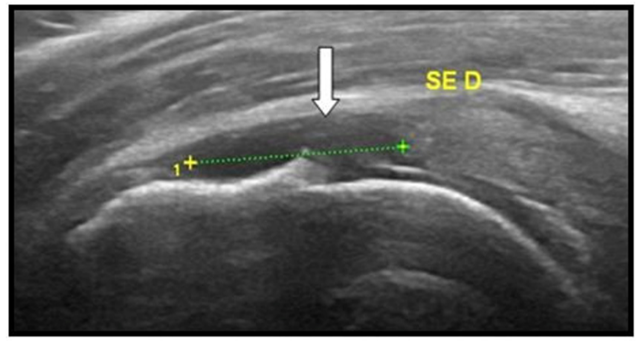

Figure 1: Ultrasound section of the supra spinatus tendon in the frontal plane showing an anechogenic area (arrow) involving the entire thickness of the anterior insertion, indicating a transfixing rupture.

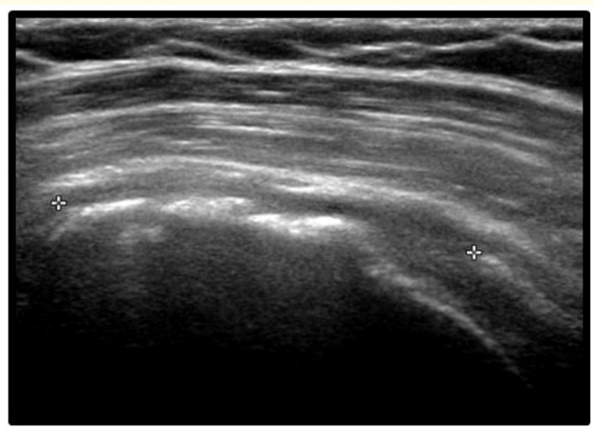

Figure 2: Ultrasound section of the supraspinatus tendon in the frontal plane showing a transfixing rupture with retraction of the tendon stump.

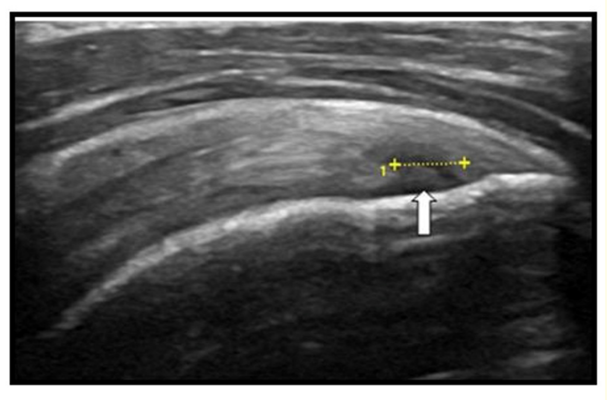

Figure 3: Coronal ultrasound section showing a hypoechoic area on the deep surface of the supra spinatus tendon (Arrow) indicating a rupture of its deep surface.

Figure 4: Coronal FATSAT DP-weighted MRI section showing a clear T2 hypersignal (arrow) of the supraspinatus insertion indicating a transfixing rupture with distal retraction of the stump (curved arrow) and subchondral trochiteal fluid geode (star).

Figure 5: Coronal section in DP FAT SAT weighting showing a liquid T2 hypersignal at the level of the deep supra spinous bundle (Arrow). There is a small amount of effusion in the sub arcomio cutaneous bursa (curved arrow).

The positive and negative predictive values for the detection of supra spinatus tendon transfixing ruptures were calculated at 90% and 72%, respectively, for ultrasound compared with 100% and 88% for MRI. The p value of Fisher's two-tailed exact test was less than 0.01, so the diagnostic value of MRI in detecting transfixing ruptures of the supraspinatus was statistically significant.

These same parameters varied respectively from 50% to 100% and 83% to 94% for the detection of nontransfixing ruptures of the supra spinatus tendon by ultrasound and from 82% to 100% and 97% to 100% by MRI.

The Se of ultrasound was better for the detection of deep ruptures than for superficial or intra-tendon ruptures. This was calculated as 67% versus 33% with a specificity of 97% for superficial and deep ruptures and 100% for cleavages. The positive and negative predictive values were 80% and 94% for deep ruptures, 100% and 83% for intratendinous ruptures and 50 and 94% for superficial ruptures.

MRI had a Se, specificity, positive predictive value, and negative predictive value of 100% in the detection of superficial ruptures. It also had interesting results for ruptures of the deep aspect with parameters calculated at 83%, 100%, 100% and 97% respectively. Its performance in the detection of intra-tendon ruptures was also remarkable. Its parameters were calculated at 100%, 93%, 82% and 100%.

This better performance of MRI was also demonstrated by calculation of the Youden test. Ultrasound, which performed less well than MRI, had a value of 0.65 versus 0.91 in the diagnosis of transfixing ruptures. For nontransfixing ruptures, these values ranged from 0.30 to 0.65 for ultrasound versus 0.83 to 1 for MRI.

The infraspinatus tendon was affected 15 times, with 9 transfixing ruptures and 6 non-transfixing ruptures. These lesions were evoked respectively 7 and 3 times in ultrasound (Figure 6) and 9 and 6 times in MRI (Figure 7) with an excellent Se and Sp of 100% in MRI against 56% and 93% in Ultrasound.

The positive and negative predictive values for the detection of transfixing ruptures of the infra spinatus tendon were calculated at 71% and 87%, respectively, in ultrasound, compared with 100% for these two parameters in MRI. However, these predictive values varied respectively from 97% to 100% and 92% to 100% for the detection of non-transfixing ruptures of the infra spinatus tendon in ultrasound. The positive predictive value was 100% and the negative predictive value ranged from 97% to 100 in MRI.

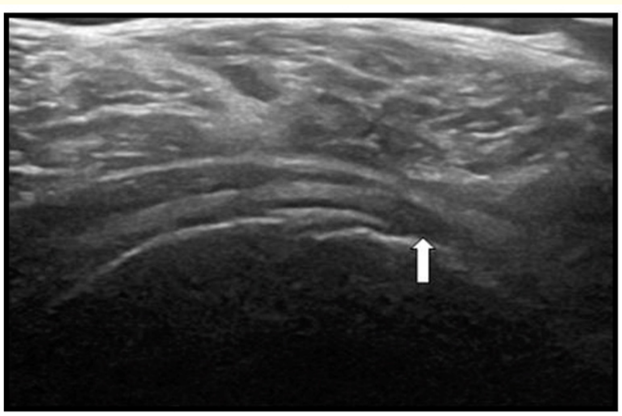

Figure 6: Coronal ultrasound section showing a very hypoechoic area (arrow) at the insertion of the infraspinatus tendon, indicating a transfixing rupture.

Figure 7: Coronal section in DP FAT SAT weighting showing a tranfixing rupture of the IE tendon (arrow).

Ultrasound was also more sensitive in the diagnosis of deep ruptures than for superficial or intra-tendon ruptures. This was calculated at 100% compared with 25% and 33%. The specificity for these three types of rupture was calculated at 97%, 100% and 100% respectively. The positive predictive value was 100% for superficial and intratendinous ruptures and 97% for deep ruptures.

However, MRI had sensitivity, specificity, positive predictive value, and negative predictive value values of 100% for superficial and deep infraspinatus tendon ruptures and of 67%, 100%, 100%, and 97%.

This better performance of MRI was also demonstrated by the Youden test with values of 1 versus 0.49 for ultrasound in the diagnosis of transfixing ruptures. The Youden test was also calculated to be 1 for superficial and deep ruptures and 0.67 for intra-tendon ruptures in MRI versus 0.25, 0.7 and 0.33 respectively for these same types of lesions in ultrasound. Fisher's p is less than 0.01 which makes these values statistically significant.

Seven subscapular tendon disinsertions were found intraoperatively, evoked 7 times by ultrasound (Figure 8) with a sensitivity and specificity of 57% and 87% and 6 times by MRI (Figure 9) with a sensitivity and specificity of 86% and 100%.

Figure 8: Ultrasound section of the subscapular tendon showing tendon disinsertion (Arrow).

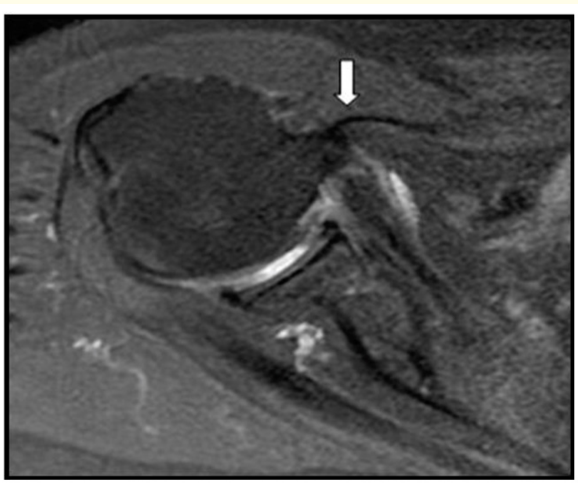

Figure 9: Axial section in DP FAT SAT weighting showing disinsertion of the subscapular tendon (Arrow).

The positive and negative predictive value of ultrasound in the diagnosis of subscapular tendon disinsertions were calculated at 50% and 90%, respectively, compared with 100% and 97% for MRI. The p of Fisher's exact test was less than 0.01. MRI had significant diagnostic value in detecting subscapularis disinsertions.

Our results showed that ultrasound is as effective as MRI in detecting dislocations of the long biceps tendon with a Se and Sp of 100% and positive predictive value and negative predictive value also calculated at 100% and this is probably due to the reduced number of dislocations found 3 times intraoperatively. The p of Fisher's exact test is less than 0.05.

We concluded that MRI was significantly more sensitive than ultrasound in the diagnosis of most rotator cuff tendon tears. While MRI sensitivity ranged from 67 to 100%, ultrasound sensitivity was as high as 33% in the study of superficial supraspinatus tendon ruptures or intraspinatus tendon cleavages. It was calculated at 25% in the study of partial ruptures of the infraspinatus tendon.

However, ultrasound was as effective as MRI in detecting dislocations of the long biceps tendon with a sensitivity and specificity of 100%, probably due to the small number of dislocations found intraoperatively (Figure 10-11). The p of Fisher's exact test is less than 0.05. Ultrasound has a statistically significant value in the detection of dislocations of the long biceps tendon.

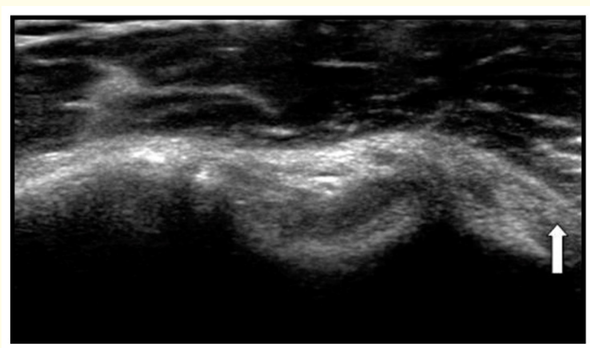

Figure 10: Ultrasound axial section of the long biceps tendon showing a dislocation of the tendon (Arrow).

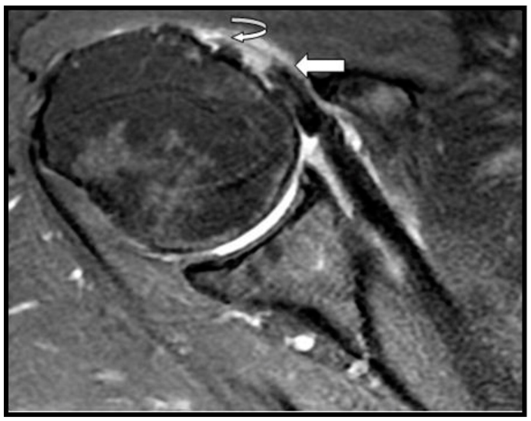

Figure 11: DP FAT SAT axial section showing disinsertion of the subscapularis tendon (arrow) associated with medial dislocation of the long biceps tendon (curved arrow).

Discussion

The rupture of the rotator cuff, whose etiologies are numerous and varied, is among the most frequent causes of pain and dysfunction of the shoulder [2]. The role of imaging in such circumstances is therefore to identify the causative factors and to specify the extent of the tendon injuries and their extension.

The ultrasound criteria for a transfixing tear have been well described in the literature [4-6]. They include direct signs such as non visualization of the cuff, localized thinning resulting in an upper concavity of the rupture zone, interruption of the tendon fibers replaced by a hypoechoic transfixing zone and indirect signs such as cortical irregularities of the major tubercle, visualization of a hyperechoic line at the superficial edge of the cartilage, double fluid effusion intra-articular and in the subacromial bursa. The MRI criterion for a transfixing rupture is the presence of a solution of continuity in frank liquid hypersignalT2 over the entire thickness of the tendon communicating the subacromial-deltoid bursa with the glenohumeral joint [3].

In our series, ultrasound has a good sensitivity of 78% in the diagnosis of transfixing ruptures, similar to that reported in the literature [7]. MRI has a sensitivity of 91% in the diagnosis of transfixing ruptures, also close to that reported in the literature [8,9].

The Se of ultrasound in the detection of transfixing ruptures of the infraspinatus is less good than for the supraspinatus (56%) and its specificity is 93%, which is consistent with the results found in the literature [10]. As for MRI, its sensitivity in the detection of transfixing ruptures of the infraspinous is clearly better than that of ultrasound (100%). Its specificity is also 100%, thus agreeing with the results found in the literature [8].

Non-transfixing ruptures are more difficult to confirm on ultrasound than transfixing ruptures. The series reported in the literature are very heterogeneous with a sensitivity varying from 13% to 93% and a specificity varying from 20% to 94% [8,11,12].

On MRI, the diagnosis of non-transfixing ruptures is less obvious than transfixing ruptures, but still easier than on ultrasound. The prevalence of partial tears was 20% (range 3% to 37%). The sensitivity and specificity of MRI were 74% and 93% respectively [8].

MRI at 3T is of interest in the study of small lesions, particularly non-transfixing ruptures [3,13]. The increase in magnetic field at 3T allows a gain in signal, improving the "signal/noise" and "contrast/noise" ratios.

Isolated subscapularis disinsertions are rare [14]. They represent 4% of cases in a series of 93 cases of cuff tears diagnosed on MRI and about 8% of operated cuff tears [15]. In our series, we have isolated only one isolated subscapularis tendon disinsertion occurring after a trauma. Most often, these disinsertions prolong a supraspinous rupture, and constitute an element of unfavorable prognosis. In our series, 6 out of 7 disinsertions were associated with a supraspinatus rupture.

The diagnosis of subscapularis tendon disinsertions and cleavages is difficult both clinically and on imaging; it is also difficult on MRI and surgery if these ruptures have not been previously suspected. In cadaveric studies, the prevalence of subscapularis tendon tears varies between 29 and 37% [16], whereas it is estimated between 5 and 27% in clinical studies [17,18]. This difference could be related to incomplete visualization of the subscapularis tendon on both arthroscopy and open surgery [19].

A lesion of the long biceps tendon was observed on ultrasound with a frequency of 8% in our series. This frequency is consistent with that described in the literature [20].

Our study showed that ultrasound is very efficient in detecting ruptures of the long biceps tendon with a high Se and Sp (100% each). Several studies have shown that ultrasound is capable of diagnosing all dislocations of the long biceps tendon [21,22]. According to a study done in Greece in 2012, it has been shown that MRI allows excellent visualization of the superior labral complex, bicipital tendon, bicipital groove, and the presence of all bony osteophytes. Consequently, it allows the diagnosis of partial and complete ruptures of the long biceps tendon. However, the quality of the MRI studies is not consistent. As a result, MRI findings correlate poorly with arthroscopic findings especially in the diagnosis of partial tears and tendonitis [23].

Conclusion

In conclusion, our study confirmed the literature data concerning the performance of MRI in the detection of rotator cuff tears, its better sensitivity and specificity compared to ultrasound for the detection of small tears, in particular partial-thickness tears and to establish an exhaustive assessment of the entire peri articular atmosphere.

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